

THE DIAGNOSIS OF DRUNKENNESS—A QUANTITATIVE STUDY OF ACUTE ALCOHOLIC INTOXICATION*

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THE tremendous increase of automotive traffic, with its greater speed and consequent greatly increased possibilities for serious accidents, and the difficulties incident to the enforcement of the laws arising out of the prohibition amendment to the Constitution have thrown upon the physician many more problems and increased responsibilities in connection with the diagnosis of acute alcoholic intoxication and the determination of the degree of inebriety and its relationship to subsequent acts of the individual. The multitude of other pathological conditions, moreover, which may be either masked or mimicked by the symptoms of drunkenness, emphasize to the conscientious doctor the importance of properly evaluating this factor in the examination of his patients.

The recognition of acute alcoholic intoxication may appear to present few difficulties to the untrained mind. The odor of alcohol, dilated pupils, flushed face, red nose, muscular incoordination affecting the legs, arms, and the organs of speech, with consequent staggering, swaying, reeling, groping and shaking, with slurred, confused or thick speech, alterations in behavior, with removal of normal inhibitions, garrulousness, euphoria, boisterousness, pugnacity, sluggishness, even stupor or actual coma, are commonly recognized features of this condition, which are readily discernible.

But a person may be under the influence of alcohol to an extent that seriously affects his powers and behavior, especially in such a responsible situation as driving an automobile, without presenting the entire common syndrome of drunkenness. On the other hand, not a few of the symptoms of this condition may be simulated by other conditions besides acute alcoholism. Besides those individuals who naturally exhibit some of the characteristics associated with alcoholic intoxication, or who have some congenital or acquired defect which results in such manifestations, as in many cases of vasomotor instability where dilated pupils and flushed face are constant findings, or instances of tongue-tie or stuttering and stammering, or of constitutional psychopathic inferiority with behavior peculiarities, there are a large number of pathological conditions which may produce such symptoms. Thus any acute febrile disturbance, thyrotoxicosis, or hypoglycemia resulting from insulinism, with dilated pupils, tremors, flushed face, etc., and any number of local conditions affecting the eyes, nose, or the limbs, may produce symptoms similar to acute alcoholism. So also may the lesions of the central nervous system, such as skull fracture or intracranial hemorrhage following an accident, syphilis of the brain or cord, as locomotor ataxia or paresis, multiple sclerosis,

brain tumor, Friedreich's ataxia, pernicious anemia with cord changes, early meningitis, etc.

Under the circumstances that generally prevail at the time of the usual examination for intoxication, following an accident, shock or arrest, confusing functional disturbances are apt to occur. Of course, the differentiation between all of these conditions and acute alcoholic intoxication may be readily made in the majority of instances by the absence or presence of other signs or symptoms essential for the diagnosis, but this is not always the case, and it must not be forgotten that a man suffering from one of these other conditions may, and frequently does, also suffer from the effects of drinking alcoholic liquors.

The odor of ethyl alcohol is so distinctive and marked that most people can readily identify it on the breath of a person who has recently indulged. Little argument is required, however, that the odor of alcohol is not in itself sufficient to make a diagnosis of alcoholism, since a small quantity of alcohol, far too small to have any physiological effects of the magnitude which would justify such a diagnosis, might still be amply sufficient to cause a recognizable odor around the mouth and breath of the patient. The remarkably widespread use and availability of alcoholic beverages make it difficult to state just what was the relationship between the alcohol imbibed and the symptoms, or even whether it had been absorbed at all, or simply thrust between the lips of an unconscious patient, as sometimes occurs following fainting or accidents. On the other hand, the presence of other strong odors, as every toper knows, may effectually hide or disguise the odor of liquor; thus garlic, any of the essential oils, as cloves, filthy mouth conditions or pyorrhea with consequent halitosis, acidosis with acetone in the breath, uremia or an ammoniacal breath and many other conditions may make it impossible to rely upon this simple test.

Nevertheless accurate determination of the concentration of alcohol present in the tissues of the subject offers a possible means for ascertaining the degree of alcoholic intoxication. Numerous workers have reported that alcohol, like most other drugs, produces effects directly proportional to the amount of the substance in the tissues, and a number of observers have attempted to use the concentration of alcohol in the blood as an index to the psychological and physiological state of the patient. It has been shown that alcohol, taken by mouth, becomes quite uniformly distributed throughout the body very rapidly after it has been administered, reaching its maximum concentration in the blood usually within an hour. It then gradually lessens as the alcohol is oxidized in the body, which has been found to occur at the rate of about 10 grams per hour in the average human subject. Since the concentration of alcohol in the urine is usually equal or slightly greater than that in the blood, and the amount excreted through the expired air also bears a constant relationship to the concentration in the blood, the determination of the alcoholic content of these excretions may also be utilized for the purpose of evaluating the degree of alcoholization.

The present study is concerned with the correla-

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tion of the concentration of alcohol in the excretions with the data secured by careful clinical examination of the first one hundred persons suspected of alcoholism brought to the Los Angeles General Hospital during the latter half of the year 1926 for whom such information was available. The examination usually included the following:

1. Direct question as to quantity and variety of liquor imbibed and time since the last drink.
2. If odor of alcohol is perceptible when patient exhales deeply.
3. Size of the pupils.
4. If patient's face appears flushed.
5. If patient staggers or reels when he tries to walk unassisted across hallway.
6. If patient can stand with feet together and eyes closed without swaying. (Romberg test.)
7. If patient can touch tip of nose with outstretched forefinger with eyes closed. (Coordination test.)
8. If patient can speak clearly, without slurring or mixing up syllables. (Test phrase "Methodist Episcopal" was often used.)
9. If any aberration of conduct or behavior were noted, especially garrulousness, boisterousness or pugnacity.
10. If there was any complicating injury or disease present.
11. Any other information which might be of value.
12. A specimen of urine was obtained on admission and placed in a sealed test tube on ice until examined for alcoholic content. A sample of expired air was taken in a football, and immediately tested for alcoholic content.

The methods used for the determination of alcohol in this study were devised and adapted particularly for this purpose, and numerous checks and control tests performed to insure accuracy and reliability. For determining the concentration of alcohol in the breath the patient was asked to blow up a football having a capacity of about 2000 cc. This air, while still warm, was then bubbled at a

moderate rate through 5 cc. of a hot solution of 0.33 per cent (N/15) potassium dichromate in 50 per cent concentrated sulphuric acid. The color change, from reddish yellow to greenish blue, was then measured by comparison with a series of standards previously made up by the addition of known amounts of alcohol (1, 2, 3, 4, and 5 milligrams) to 5 cc. of the reagent and sealed.

For determining the concentration of alcohol in the urine, blood or spinal fluid, 1 cc. of the unknown solution (or $\frac{1}{2}$ cc. in some cases) was placed in a test tube and a purified current of air was bubbled through this tube and then passed through 5 cc. of the potassium dichromate sulphuric acid mixture as used above for ten minutes, both tubes being immersed in a boiling-water bath. In these tests, in addition to noting the color change by comparison with known standards, as above, the amount of reduction due to the alcohol was determined more accurately by titrating with a solution of N/30 ferrous ammonium sulphate in 5 per cent sulphuric acid, using three drops of a 1 per cent solution of potassium ferricyanide as an indicator, until the deep blue color was obtained. Each 2 cc. of the ferrous ammonium sulphate solution less than 10 cc. required for this titration represented 1 milligram of alcohol in the unknown solution when 1 cc. of the urine, blood or spinal fluid, etc., was used. When acetone was present in the unknown solution, it was removed by the addition of 1 cc. of Scott Wilson's reagent before aeration.

The results of these examinations are presented in Table I. Nearly one-half of the one hundred patients in this series were kept in the hospital for treatment. In twenty-nine instances this was done because the patient was so deeply intoxicated as to be unable to stand up, and so had to be cared for until he was able to leave. In most of the other seventeen, complicating conditions such as fractures, severe wounds or lacerations, or poisoning were present. The proverbial drunkard's luck did not appear to be much in evidence, since nearly half of the patients here examined, and a greater percentage

TABLE I
CLINICAL FINDINGS IN ONE HUNDRED PATIENTS SUSPECTED OF ALCOHOLISM
Classified According to the Alcoholic Content of the Urine

Mg. alcohol per cc. urine.....	0-1	1-2	2-3	3-4	4-5	5-	Total
Patients examined.....	7	11	26	37	13	6	100
Kept in hospital.....	3	3	10	16	8	6	46
Diagnosed acute alcoholism.....	0	6	16	29	13	6	70
"Has been drinking".....	1	0	3	8	0	0	12
Insufficient evidence.....	6	5	7	0	0	0	18
Complications present.....	5	4	10	19	8	1	47
Age: Under 30 years.....	2	9	6	6	1	1	25
30 to 40 years.....	2	1	9	11	3	1	27
Over 40 years.....	0	1	4	8	5	2	20
Admit drinking.....	3	5	9	17	6	3	43
Odor of alcohol.....	3	9	21	37	13	6	88
Flushed face.....	0	3	15	16	4	2	30
Dilated pupils.....	0	2	8	16	3	1	30
Unable to walk straight.....	0	4	12	26	13	6	61
Unable to stand at all.....	0	0	5	10	8	6	29
Sway on standing (Romberg).....	1	2	14	25	5	0	47
Incoordination (marked).....	0	1	7	18	9	4	39
Behavior disturbances.....	0	2	12	24	8	0	46
Speech slurred.....	1	1	4	5	4	0	15
Speech confused.....	0	6	10	8	7	0	31
Speech, unable to talk.....	0	2	5	3	2	6	18
Comatose.....	0	0	3	7	5	6	21

TABLE II
INCIDENCE OF SYMPTOMS AT DIFFERENT CONCENTRATIONS OF ALCOHOL
Expressed as Percentage Present in Each Group

Mg. alcohol per cc. urine.....	0-1	1-2	2-3	3-4	4-5	5-	Total
Actual number of patients.....	7	11	26	37	13	6	100
Expressed as percentage.....	100	100	100	100	100	100	100
Per cent kept in hospital.....	43	28	40	43	64	100	46
Per cent diagnosed acute alcoholism.....	0	54	62	80	100	100	70
Per cent admit drinking.....	43	55	33	46	48	50	43
Per cent odor of alcohol.....	43	82	81	100	100	100	88
Per cent flushed face.....	0	27	20	43	32	33	30
Per cent dilated pupils.....	0	18	30	43	24	16	30
Per cent staggering gait.....	0	36	27	43	40	0	42
Per cent cannot stand.....	0	0	20	27	60	100	29
Per cent positive Romberg sign.....	14	18	52	72	100	100	47
Per cent incoordination.....	0	9	27	52	82	66	39
Per cent behavior disturbances.....	0	18	46	15	16	0	46
Per cent speech slurred.....	14	9	15	13	30	0	15
Per cent confused.....	0	54	38	21	53	0	31
Per cent unable to talk.....	0	18	19	8	15	100	18
Per cent comatose.....	0	0	11	20	40	100	21

of those found to be actually intoxicated, were suffering from some such complicating condition.

The relationship of the concentration of alcohol in the urine to the degree of intoxication of the subject is strikingly brought out in this table. None of the patients with less than 1 milligram of alcohol per cc. of urine were found to be intoxicated, a little more than half of those having from 1 to 2 milligrams per cc. were so diagnosed, nearly three-fourths of those having from 2 to 4 milligrams and every individual having 4 milligrams or more per cc. of urine were so pronounced. These diagnoses were naturally very conservatively made, since the receiving physician was called to court to sustain his impression in many cases, and unmistakable clinical evidence was insisted upon for this purpose.

Even more striking is the relationship between the concentration of alcohol in the urine and the different symptoms usually considered indicative of acute alcoholism. The odor of alcohol was present in less than half of those showing under 1 milligram of alcohol per cc. urine, in more than three-fourths of those showing from 1 to 3 milligrams, and in every instance where the urine contained

3 milligrams or more of alcohol per cc. On the other hand, the dilated pupils and flushed face, so frequently called on as evidence, were found in less than one-third of these cases, and were particularly noted in the moderate groups, being replaced by constricted pupils and pallor in a high proportion of those coming in in coma, or stuporous.

The inability to stand straight without swaying is generally accepted as a characteristic symptom of acute alcoholism. More than three-fourths of the patients in this series showed this sign, of whom twenty-nine, as noted above, were unable to stand at all. The swaying was noted in less than 20 per cent of those showing under 2 milligrams of alcohol in the urine, but in more than 80 per cent of the others who were able to stand at all. In no case with 3 milligrams or more was the subject able to stand without swaying. Marked incoordination of the hands was recorded in thirty-nine cases, and was most frequently found in those who had more than 3 milligrams per cc. Behavior disturbances, on the other hand, including garrulousness, volubility, euphoria, boisterousness or pugnacity was more pronounced in those showing from 2 to 4 milligrams,

TABLE III
INCIDENCE OF SYMPTOMS AT DIFFERENT CONCENTRATIONS OF ALCOHOL
Expressed as Percentage Present of Those Showing That Symptom

Mg. alcohol per cc. urine.....	0-1	1-2	2-3	3-4	4-5	5-	Total
Per cent actual number of patients.....	7	11	26	37	13	6	100
Per cent kept in hospital.....	7	7	22	34	17	13	100
Per cent diagnosed acute alcoholism.....	0	8	23	43	18	8	100
Per cent insufficient evidence.....	33	28	39	0	0	0	100
Per cent under 30 years of age.....	8	36	24	24	4	4	100
Per cent 30 to 40 years of age.....	7	4	33	41	11	4	100
Per cent over 40 years of age.....	0	5	20	40	25	10	100
Per cent admit drinking.....	7	12	21	39	14	7	100
Per cent odor of alcohol.....	3	10	23	42	15	7	100
Per cent flushed face.....	0	10	17	52	13	8	100
Per cent dilated pupils.....	0	8	27	52	10	3	100
Per cent unable to stand up.....	0	0	17	35	28	20	100
Per cent staggering gait.....	0	12	22	50	16	0	100
Per cent positive Romberg sign.....	2	4	30	53	11	0	100
Per cent incoordination.....	0	2	16	48	28	8	100
Per cent behavior disturbances.....	0	4	26	53	17	0	100
Per cent speech disturbance.....	1	14	31	25	20	9	100
Per cent comatose.....	0	0	14	33	24	29	100

TABLE IV
CONCENTRATION OF ALCOHOL IN THE BREATH AS AN INDEX TO INTOXICATION

Mg. alcohol per 2 liters breath.....	0-1	1-2	2-3	3-4	4-	Total
Diagnosed alcoholic intoxication.....	2	12	12	7	2	35
Insufficient evidence.....	9	3	3	0	0	15
Total.....	11	15	15	7	2	50

as above that they tended to lapse into sluggishness, stupor or coma.

Speech disturbances varied from a slight slurring or thickening of speech, or a sluggishness or spacing of syllables to confusion, verbigeration, and eventually inability to enunciate at all. Two out of every three patients examined showed some defect in ability to speak, but this, of course, varied considerably according to the ability and previous experience of the individual, being more marked in some patients with lower concentrations of alcohol than in others who had a much higher figure.

It is interesting to note that the age distribution in the different groups varied with the concentration of alcohol in the urine, being lowest in those with low concentrations and highest in those who had the highest concentrations. This is believed, from personal acquaintance with the material at hand, to be related to differences in social and individual factors, such as the prevalence of solitary drinking among the aged, etc., rather than to increased tolerance or higher metabolic activity among the younger men. Of course in this series the subjects were mainly men, but a few women were included. A number of negroes were also included, although most of the patients were white.

The relative proportions of the different groups showing each symptom is presented in Table II, and the proportion of those showing that symptom in each group is shown in Table III.

The question of tolerance to alcohol is, of course, of paramount importance in a study of this kind. That some individuals are able to drink many times the amount of alcohol as others is a matter of common information. There are, of course, three possible explanations for this phenomenon. Delayed absorption of the alcohol is probably an important factor, as Hanzlik showed in animal experiments, and this is suggested in the curves for alcohol concentration in the blood of certain of our patients, where the peak for habitues came later than that for those with lower tolerance. That the rate of oxidation of alcohol may be increased in persons habituated to the drug is very plausible, and is suggested by some of the figures presented by Higgins

and Miles, on the combustion of alcohol as shown in the respiratory quotient, although Mellanby reported that the amount of alcohol utilized in the body does not vary greatly in different individuals. The third possibility, that the tissues may become resistant to higher concentrations of alcohol, would preclude the acceptance of the concentration of alcohol as an index to the degree of intoxication. Experimental evidence on this point is not yet conclusive, but the uniformity of the results presented in Tables I, II, III, IV, and VI are convincing, for this series at least, that this cannot be taken as occurring to any great extent. In other words, it appears that the development of tolerance to alcohol consists in greatly retarded absorption, and perhaps in increased rate of oxidation of the alcohol, but that the tissues are always affected to about the same degree by the same concentration of alcohol in the body, independent of the habituation of the individual.

The concentration of alcohol in the urine cannot be taken as an absolute indication of the alcoholic concentration in the patient's tissues because of lack of information as to the time period during which that urine had been secreted, as it would, on the whole, represent the summation of all of the different concentration existing during the period of secretion, although the work of Nicloux indicates that there may be some resorption of alcohol from the bladder if the concentration in the urine becomes much higher than that in the blood. Southgate and Carter met this objection by having the patient void on admission and again fifteen minutes later, and taking the latter sample as representing the condition of the patient at this time. We have had some difficulty in obtaining specimens of urine, as catheterization is not always justified in such cases, and there is often insufficient time for further procedures, and so have looked for some simpler method of making this determination.

The concentration of alcohol in the breath, as shown in Tables IV and Table V, offers a very attractive-looking substitute. As soon as the disturbing factor of the alcoholic liquor still in the mouth and lips is removed, the concentration of

TABLE V
CONCENTRATION OF ALCOHOL IN THE BREATH COMPARED WITH THAT IN THE URINE

Mg. alcohol per 2 liters, breath.....	0-1	1-2	2-3	3-4	4-	Total
Mg. alcohol per 1 cc., urine 0-1.....	1	1	4	0	0	6
1-2.....	1	2	4	4	0	11
2-3.....	0	1	4	3	0	8
3-4.....	0	0	4	3	0	7
4-.....	0	0	1	1	1	3
Total.....	2	4	17	11	1	35

TABLE VI
CONCENTRATION OF ALCOHOL IN THE SPINAL FLUID COMPARED WITH THAT IN THE URINE

Mg. alcohol per cc. spinal fluid.....	0-1	1-2	2-3	3-4	4-5	5-	Total
Mg. alcohol per cc. urine 0-1.....	0	0	0	0	0	0	0
1-2.....	0	0	0	0	0	0	0
2-3.....	0	0	1	1	0	0	2
3-4.....	0	0	0	0	0	0	0
4-5.....	0	0	0	0	3	1	4
5-.....	0	0	0	0	1	3	4
Total.....	0	0	1	1	4	4	10

alcohol in the breath approaches a fairly constant relationship to that in the blood, since it passes through the lungs very easily. As may be seen in Table IV, less than 20 per cent of patients having less than 1 milligram of alcohol in the sample of breath taken were found to be intoxicated, as compared to 80 per cent of those having from 1 to 3 milligrams and 100 per cent of those having 3 milligrams or more. Table V shows how the breath alcoholic concentration keeps pace with that in the urine, although, as may be expected from the considerations given above, it could not be expected to give a perfect check.

The concentration of alcohol in the spinal fluid was determined in ten instances. In eight cases where the urinary alcoholic concentration was more than 4 milligrams per cc., the spinal fluid also contained more than 4 milligrams per cc. as shown in Table VI. In the other two cases, where the urinary alcoholic concentration was between 2 and 3 milligrams, the spinal fluid contained 2 milligrams per cc. in one case and 3 milligrams per cc. in the other. The concentration of alcohol in the blood was also determined in fifteen instances, but it was found that in the blood the alcohol was destroyed on standing so rapidly that the determinations gave much too low figures except in those cases where this determination could be done within a very short time after the blood was taken, as shown in Table VII.

In view of the difficulty in making the diagnosis of acute alcoholic intoxication from the clinical evidence alone, as may be confirmed from a review of the data in the cases above presented, and in view of the constancy of the findings as to the concentration of alcohol in the urine and in the breath with reference to the degree of alcoholic intoxication, it is concluded that the examination of patients to determine the state of intoxication should in every case include some quantitative determination of the amount of alcohol present in the urine, breath, or body fluids. It is not expected that such test should

supersede and entirely replace all of the other clinical evidence presented, but, as any laboratory test, it must be interpreted in the light of the findings in the individual case. A study of the results in the series of cases just analyzed, however, as well as those reported by many other observers, notably Nicloux, Widmark, Schweisheimer, Miles, Mellanby, Southgate and Carter, and many others, leads us to rely upon the alcoholic concentration in the urine, breath or tissues as the most important single factor in arriving at a correct conclusion as to the degree of intoxication of a patient.

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TABLE VII
CONCENTRATION OF ALCOHOL IN THE BLOOD COMPARED WITH THAT IN THE URINE

Mg. alcohol per cc. blood.....	0-1	1-2	2-3	3-4	4-5	5-	Total
Mg. alcohol per cc. urine 0-1.....	1	0	0	0	0	0	1
1-2.....	0	0	0	0	0	0	0
2-3.....	2	1	0	1	0	0	4
3-4.....	0	2	0	0	1	0	3
4-5.....	1	1	2	0	0	1	5
5-.....	1	0	0	0	1	0	2
Total.....	5	4	2	1	2	1	15

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ASSOCIATED FEES—MEDICAL AND SURGICAL*

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THE chairman of the General Surgery Section of this society is honored in the privilege of addressing you in formally opening the session. Inclination impels toward some subject of scientific interest, but the technical side of the program will be ably cared for by the gentlemen to follow. For this reason your presiding officer has chosen to use the time allotted him in discussing a matter of interest to every surgeon and one even more interesting to his confrères on the medical side. It is not a pleasant subject, this matter of fees. We like to think of ourselves as scientists devoting our lives to the betterment of the physical condition of our fellowman. We believe ourselves to be all of this, but we should not fail to recognize the fact that economic factors will not be divorced from our profession until the remark of a famous Californian that "a man must eat" becomes untrue.

Let us then frankly consider the distasteful but nevertheless important financial side of our calling. And let it be understood at the outset that the purpose of this discussion is in the interest of honesty and fair dealing, to secure simple justice and full understanding between each of the concerned parties, namely, the patient, the referring physician, and the surgeon, while respecting strictly the dictum of our Code of Ethics as related to the division of fees.

The subject chosen, you will bear in mind, is "Associated Fees—Medical and Surgical." This limitation is made since it brings us directly to the discussion of a very real and as yet not satisfactorily solved problem in the practice of medicine and surgery. Until we find an answer the obnoxious subject of "fee-splitting" will be before us, and its general discussion can bring nothing but discredit to the profession. This subject was first introduced and the opprobrious name applied in an honest attempt to eradicate an unethical practice on the part of a comparatively few surgeons. Unfortunately the effect of the discussion has been to cast suspicion upon surgeons generally—upon a body of men whose unselfish devotion to duty and ethical standards are

* Chairman's address, Section on General Surgery, at the Fifty-Sixth Annual Session, California Medical Association, April 25-28, 1927.